Asymmetric flow field-flow fractionation for the detection and characterization of nanoparticles in food – a short tutorial

Katrin Loeschner

With the increasing use of nanotechnology in food and consumer products, there is a need for reliable detection and characterization methods for nanoparticles (NPs) in complex matrices. NPs often interact with each other or with their surroundings leading to aggregation, adhesion to surfaces or dissolution in dispersion solvents. Accurate and precise characterization of metrics such as size, shape, particle mass and number concentration therefore remains a challenging analytical task. In order to determine quantitative metrics that are relevant in food monitoring or in risk assessment, asymmetric flow field-flow fractionation (AF^4) hyphenated with optical detectors and inductively coupled plasma mass spectrometry (ICP-MS) has proven to be a powerful technique [1,2]. Several parameters of the AF^4 influence the separation, including carrier liquid composition, membrane material, cross flow rate, spacer height, focus flow rate, focus time and injected mass. In order to acquire accurate data the AF^4 separation method must be optimized for each new sample matrix and analyte NP combination [1,3,4].

This tutorial will give guidance for the application of AF^4 to the detection and characterization of NPs in food. The most important AF^4 separation parameters will be identified and described. The use and relevance of different detection methods, like multi-angle and dynamic light scattering, absorbance, ICP-MS and the new ICP-QQQ-MS, will be presented. Furthermore, the need for suitable sample preparation methods and independent verification of the results, e.g. by transmission electron microscopy (TEM) or single particle ICP-MS, will be highlighted. Finally, the possibility for determination of number-based particle size distribution will be discussed. The determination of a size distribution based on particle number is relevant for future regulatory purposes because of the European Commission's recommendation of the definition of a nanomaterial as a "natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm–100 nm" [5].

(1) Loeschner, K.; Navratilova, J.; Legros, S.; Wagner, S.; Grombe, R.; Snell, J.; von der Kammer, F.; Larsen, E. H. J. Chromatogr. A 2013, 1272, 116–125.

(2) Loeschner, K.; Navratilova, J.; Grombe, R.; Linsinger, T. P. J.; Købler, C.; Mølhave, K.; Larsen, E. H. Food Chem. 2015, 181, 78–84.

(3) Loeschner, K.; Navratilova, J.; Købler, C.; Mølhave, K.; Wagner, S.; von der Kammer, F.;

Larsen, E. H. Anal. Bioanal. Chem. 2013, 405 (25), 8185–8195.

(4) Kammer, F. Von Der; Legros, S.; Hofmann, T.; Larsen, E. H.; Loeschner, K. TrAC Trends Anal. Chem. 2011, 30 (3), 425–436.

(5) EC (European Commission), Off. J. Eur. Union 2011, 275, 38–40.